

### **Progression in scientific understanding of concepts:**

#### **A strategy for assessing scientific knowledge without levelling**

The new curriculum for science has been planned to try to ensure that the concepts that children encounter become increasingly more complex as they move through the school. It is important that for each concept the children meet they master it in sufficient depth and breadth so as to not have purely a superficial level of understanding; the children are expected to know, understand and apply each concept.

The stages (see next page) show how children may develop understanding of a scientific idea. To show that they have grasped a concept it is expected that they would be able to demonstrate that they have reached stage 4/5. A child in year 1 will be meeting easier concepts than those met by older children. Cognitively the concept will be easier to grasp and the related vocabulary will be more basic. Therefore a year 1 child would be expected to reach stage 4/5 for a year 1 concept. A year 6 child will be meeting more challenging concepts with a greater range of scientific vocabulary and would also be expected to reach stage 4/5. These are NOT levels as the concepts that the children meet in KS1 are simpler than those in KS2 – a key stage 1 child demonstrating stage 5 is very different to a year 6 child.

Following the stages on the next page, are some examples of children's written work to demonstrate how these stages of understanding may be applied in different year groups for different topics. This is currently work in progress. It is hoped to add further examples at a later date.

Written evidence is not the only way that teachers will assess children's understanding against a concept. It is important that they also listen to and question the children.

## Progression in understanding

1

Observes an object, living thing or event and comments on it

The giraffe has a long neck.  
The ice cube is cold.  
That's a bright light.  
I can switch the light on and off.  
The ice cube is turning to water.

2

Make comparisons between objects, living things or events, noticing similarities and differences.

The donkey has bigger ears than the horse.  
The radiator is hotter than the hot water bottle.  
The torch is brighter than the candle.  
The small ice cube is turning to water more quickly.  
People all have eyes but they can be different colours.  
Sandpaper and felt are both bendy, but the sandpaper is much rougher.  
Both balls bounce, but the tennis ball bounces higher than the football.

3

Link cause and effect

Give simple explanations

My heart is beating faster because I am exercising harder.  
The water handprint on the paper towel disappears more quickly when I put it on the radiator.  
The harder I push the car the further it travels.

Plastic is a good material for a raincoat because it is waterproof.  
If you do not water a plant it dies as it need water to be healthy.  
The car moves more easily on the wood than the carpet as the carpet slows it down.

4

Show scientific understanding and use scientific vocabulary correctly

The harder you exercise the faster your heart beats in order to pump the blood around your body to provide the muscles with the oxygen they require.  
When you add sugar to water it dissolves as it is soluble in water.  
The parachute causes the object to fall more slowly due to air resistance.

5

Demonstrate understanding of scientific vocabulary

Apply knowledge in familiar contexts

When the size of the parachute increases the object falls more slowly as more air is trapped underneath the canopy which increases the air resistance.

You want a floor mat in the bathroom to have high friction so that you not slip on it, but a mat to be used on a helter skelter should be low friction.

6

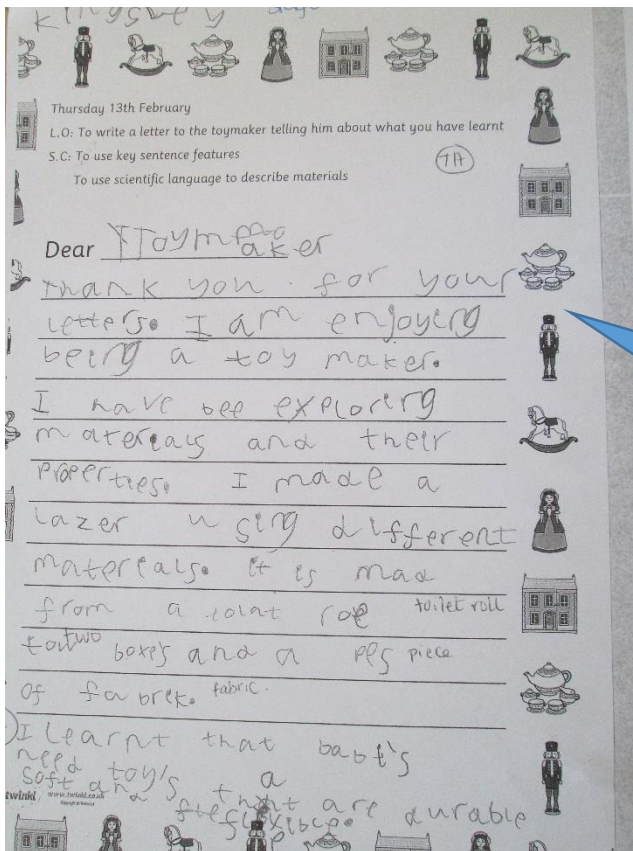
Apply knowledge in an unfamiliar context

(After investigating parachutes)  
Aeroplanes and rockets are shaped to reduce air resistance so that they can move more easily through the air and therefore go faster.

# Materials and their properties

Year 1 national curriculum objective:

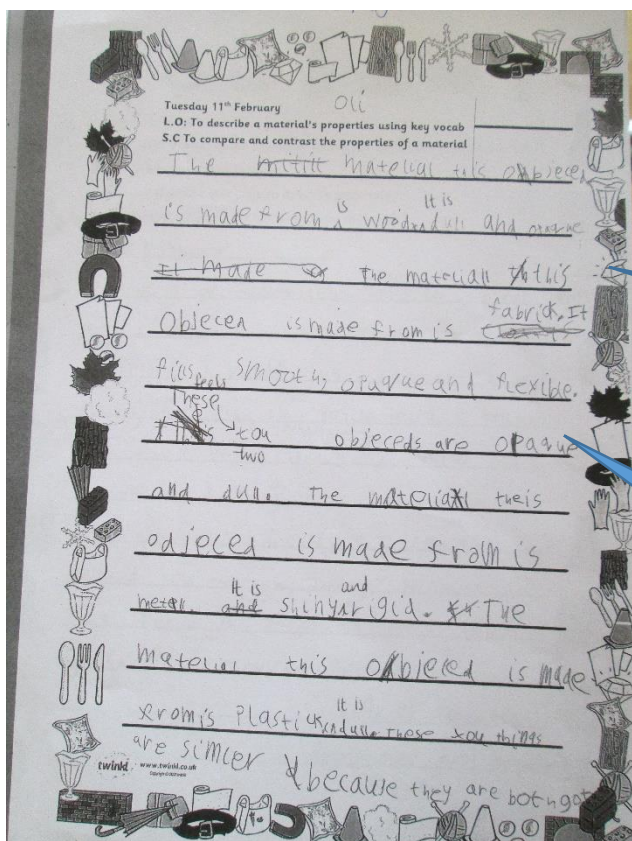
- Distinguish between an object and the material from which it is made
- Identify and name a variety of everyday materials, including wood, plastic, glass, metal, water and rock
- Describe the simple physical properties of everyday materials



Dear Toymaker

Thank you for your letters. I am enjoying being a toymaker. I have been exploring materials and their properties. I made a lazer using different materials. It is made from a toilet roll and two boxes and a piece of fabric. I learnt that babies need soft toys that are durable soft and flexible

Stage 1 – the writing does not show a clear awareness of the difference between an object and the material it is made from. Some properties of materials are mentioned at the end but this is not in relation to a particular toy.



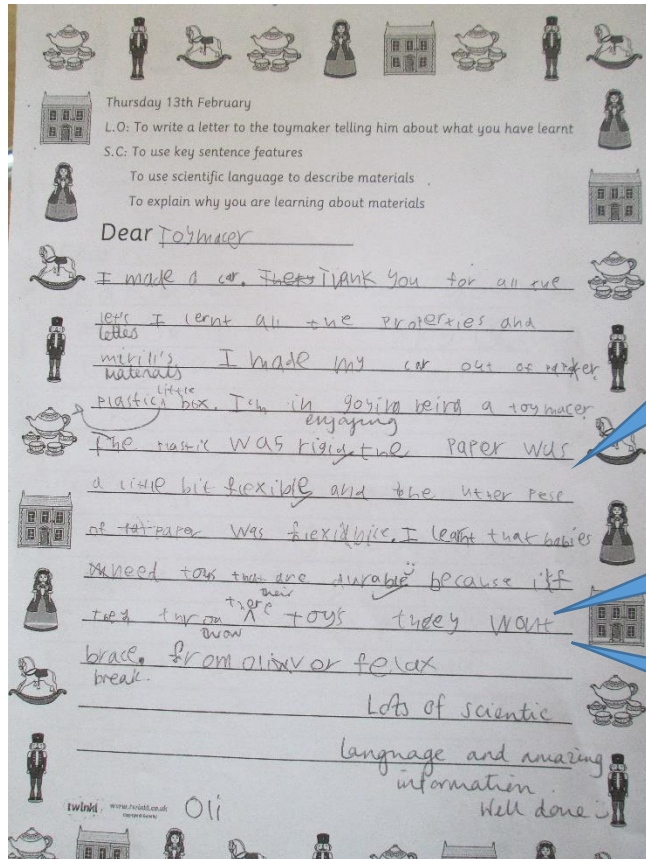
The material this object is made from is wood. It is dull and opaque. The material this object is made from is fabric. It feels smooth, opaque and flexible. These two objects are opaque and dull. The material this object is made from is metal. It is shiny and rigid. The material this object is made from is plastic. It is dull. These two things are similar because they are both .....

Stage 1 – most of the writing describes individual objects

Here, and in the incomplete final sentence the child is starting to compare objects, beginnings of stage 2.

Dear toymaker

I made a car. Thank you for all the letters I learnt all the properties and materials. I made my car out of paper and little plastic boxes. I'm enjoying being a toymaker. The plastic was rigid, the paper was a little bit flexible and the piece of paper was flexible. I learnt that babies need toys that are durable because if they throw their toys they won't break.



Stage 2 – is comparing the flexibility of two different types of paper

Stage 3 – links cause and effect

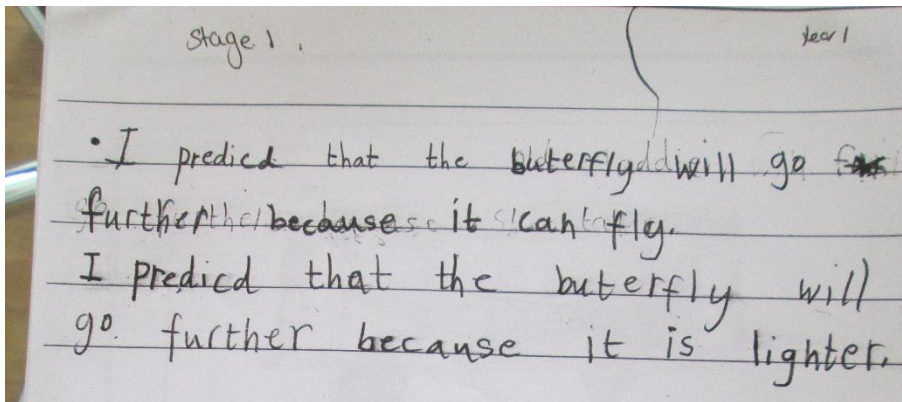
Stage 4 – shows an understanding of the word durable

# Forces

Year 3 national curriculum objective:

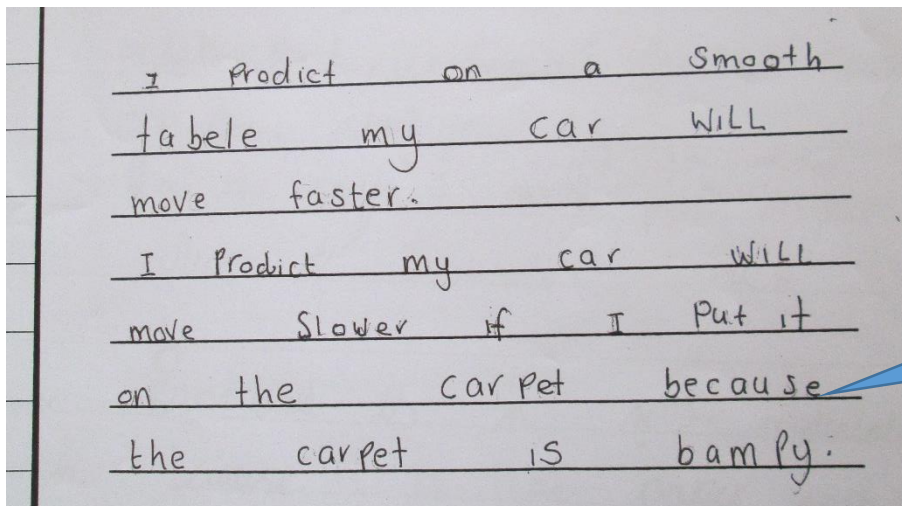
- Compare how things move on different surfaces

I predict that the butterfly will go further because it can fly. I predict that the butterfly will go further because it is lighter.



Stage 1 – the child has totally missed the point of the investigation and is not relating this prediction to the toys being tested

I predict on a smooth table my car will move faster. I predict my car will move slower if I put it on the carpet because the carpet is bumpy.



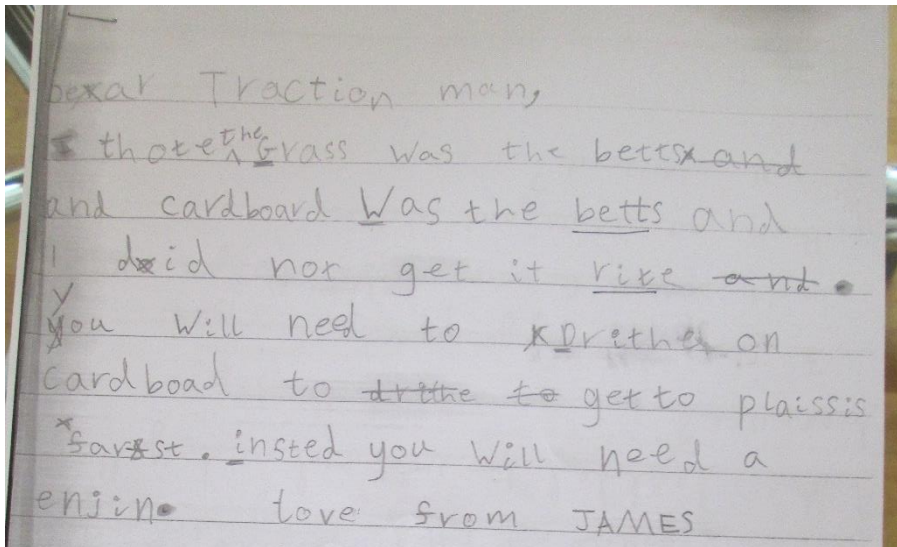
Stage 2 – there is a comparison of the movement on the table and the carpet

Stage 3 – the child links cause and effect



Dear Traction man,

I thought the grass was the best and cardboard was the best and I did not get it right. You will need to drive on the cardboard to get to places fast. Instead you will need an engine.



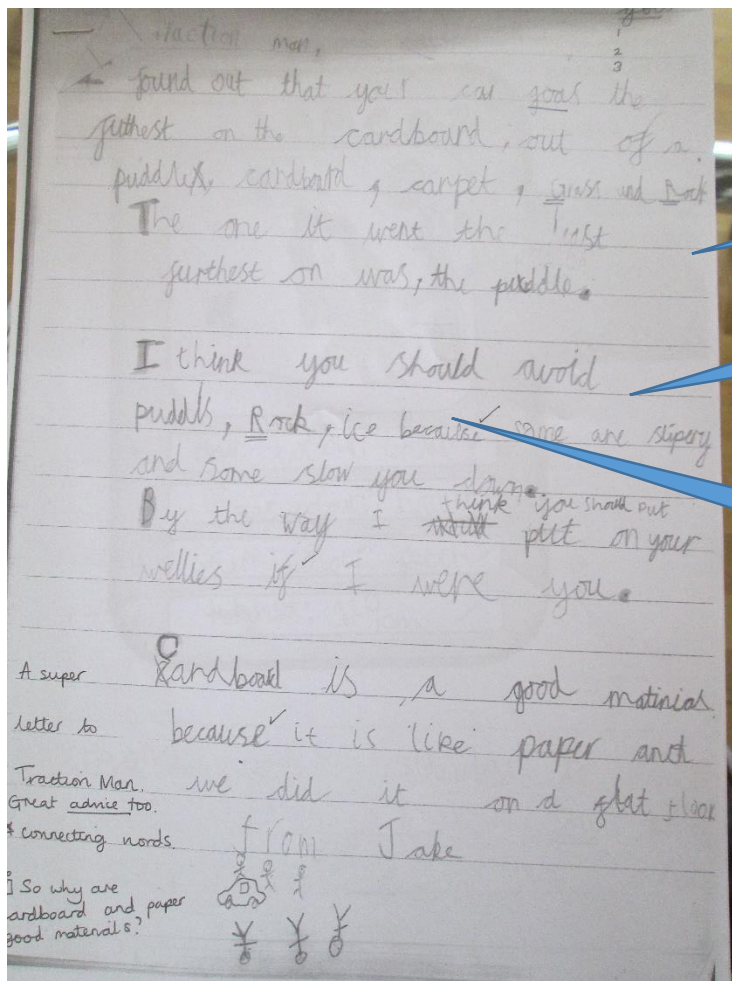
Stage 1 – there is reference to the car being better on the cardboard than on the grass but this is implied. If this comparison was made explicit it would show evidence for stage 2

I found out that your car goes the furthest on the cardboard, out of puddles, cardboard, carpet, grass and rock. The one it went the least furthest on was the puddle.

I think you should avoid puddles, rock, ice because some are slippery and some slow you down.

By the way I think you should put on your wellies if I were you.

Cardboard is a good material because it is like paper and we did it on a flat floor.



Stage 2 – there is an explicit comparison between the different surfaces

Stage 3 – linking cause and effect 'Some surfaces slow you down.'

Stage 5 – applies knowledge to the familiar context of ice being slippery.

# Separating materials

Year 5 national curriculum objective:

- use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating

We have been separating materials. So we had two materials and we used a sieve or filter paper and a funnel and we tried separating our materials. For example we put soil in water and we used a sieve and we tipped the dirty water into the sieve and underneath there was a jug and the water went into the jug and the soil stayed in the sieve that means the experiment worked. And the other one is where you use iron filings and you get a magnet and the iron filings get stuck to the magnet and it works.

⑤ We have been separating materials. So we had two materials and we used a sieve and or filter paper and a funnel and we tried separating our materials. for example we put soil in water and we used a sieve and we tipped the dirty water into the sieve and under neath the was a jug and the water went into the jug and the soil stayed in the sieve that means the experiment worked. And the over one is were you use iron fillings and you get a magnet and the iron fillings get stuck to the magnet and it works.

Stage 2 – compares what happens to the soil and water but does not link cause and effect e.g. the particles in the soil are too big to go through the holes in the sieve or give an explanation.

You can separate materials by using the magnet, sieve and filter paper. The magnet can only be used for metal. There are lots of different shaped sieves and many different ways to use them. You can separate dirt and water using filter paper by putting the filter paper in the funnel and then slowly pouring the mixture through it will separate. If it dissolves it is called soluble if it doesn't dissolve it is called insoluble.

⑥ You can separate materials by using the magnet (only for metal), sieve and filter paper. The magnet can only be used for metal. If the sieve is used to separate dirt and water there are lots of different shaped sieves, and many different ways to use them. Filter paper you can separate dirt and water by putting the filter paper in the funnel and then slowly pouring the mixture through it will separate. If it dissolves it is called soluble / solution if it doesn't dissolve it is called insoluble.

Stage 4 – demonstrates understanding of scientific vocabulary

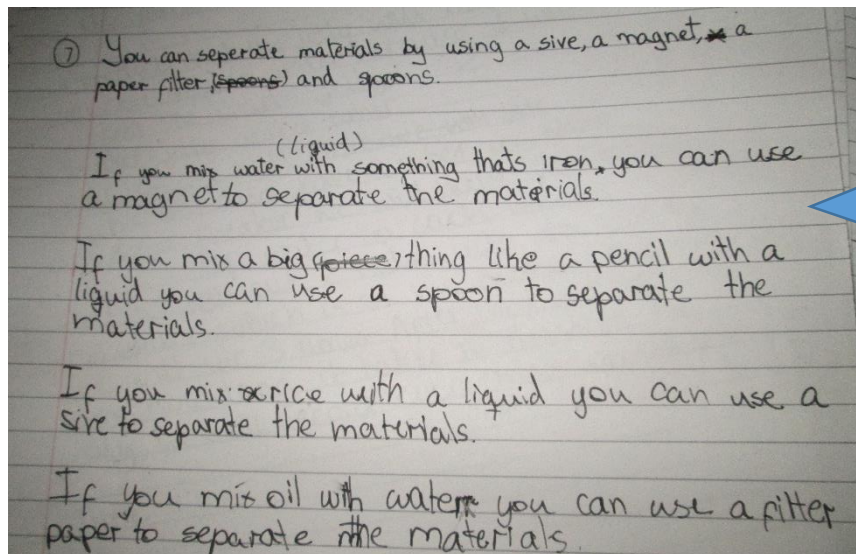
Although the last sentence demonstrates some possible understanding at stage 4, overall the rest of the writing only demonstrate stage 1 as there is no comparison between what happens to the soil and water when it is put in the filter paper or any attempt at an explanation of how the separation occurs.

You can separate materials by using a sieve, a magnet a paper filter and spoons.

If you mix water with something that [contains] iron you can use a magnet to separate the materials.

If you mix rice with a liquid you can use a sieve to separate the materials.

If you mix oil with water you can use a filter paper to separate the materials.



Stage 2 – the writing shows an awareness that different techniques will be used for different materials i.e. a comparison, but there is no explanation or linking cause and effect.



# Changing materials

Year 5 national curriculum objective:

- know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution

My aim: to find the quickest temperature to dissolve water.

My hypothesis: I predict that the jelly will dissolve quicker in cold water because it will affect the warm jelly.

I will need: a beaker, jelly and a timer

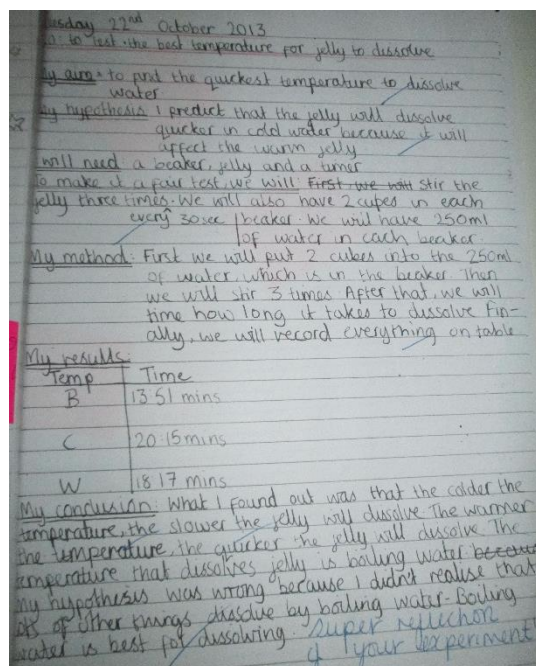
To make a fair test we will: stir the jelly tree times every 30 secs. We will also have 2 cubes in each beaker. We will have 250ml of water in each beaker.

My method: first we will put 2 cubes into the 250ml of water, which is in the beaker. Then we will stir 3 times. After that, we will time how long it takes to dissolve finally, we will record everything on table.

My results:

| Temp | Time       |
|------|------------|
| B    | 13:51 mins |
| C    | 20:15 mins |
| W    | 18:17 mins |

My conclusion: what I found out was that the colder the temperature, the slower the jelly will dissolve. The warmer the temperature, the quicker the jelly will dissolve. The temperature that dissolves jelly is boiling water. My hypothesis was wrong because I didn't realise that lots of other things dissolve by boiling water. Boiling water is best for dissolving.



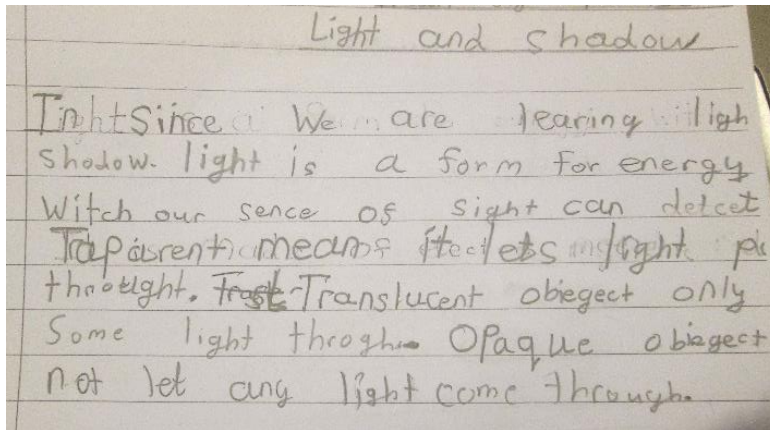
Stage 3 – this conclusion is linking cause and effect. It does not however demonstrate scientific understanding i.e. the process is not explained.

# Light

Year 3 national curriculum objective:

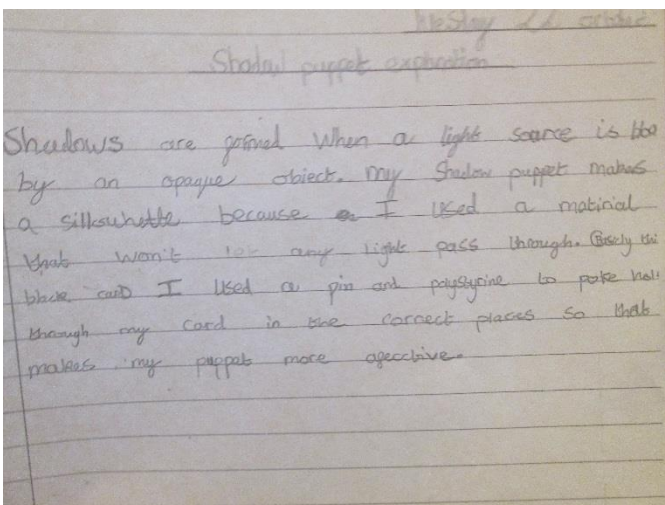
- recognise that shadows are formed when the light from a light source is blocked by a solid object

In science we are learning [about] light [and] shadow. Light is a form of energy which our sense of sight can detect. Transparent means it lets light pass through. Translucent objects only some light [passes] through. Opaque objects [do] not let any light come through.



Stage 4 - Shows scientific understanding and uses scientific vocabulary correctly

Shadows are formed when a light source is [blocked] by an opaque object. My shadow puppet makes a silhouette because I used a material that won't let any light pass through. I used a pin and polystyrene to poke holes through my card in the correct places so that makes my puppet was more effective.



Stage 5 – gives an explanation of how a shadow is formed (stage 3) uses correct scientific vocabulary (stage 4) and applies in a familiar context (stage 5)

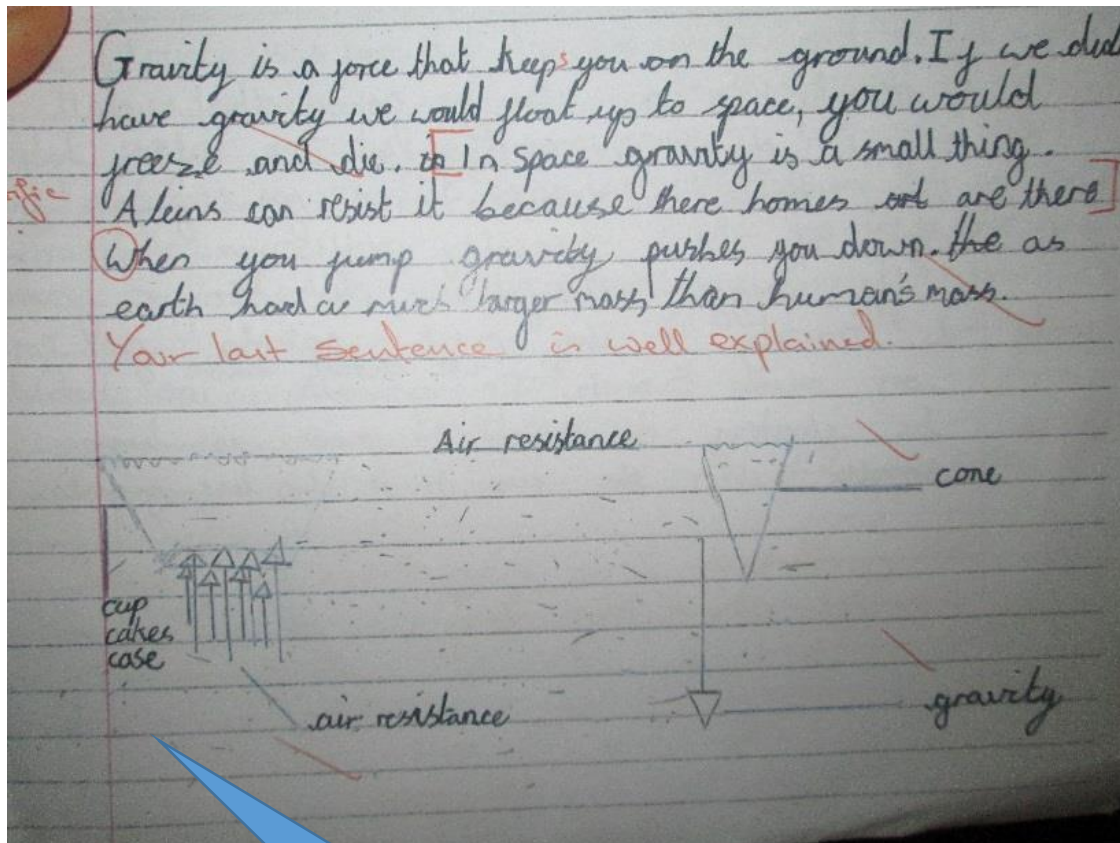
Could have been extended by explaining the effect of poking holes in the puppet.

# Forces

Year 5 national curriculum objectives:

- explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object
- identify the effects of air resistance, water resistance and friction, that act between moving surfaces

Gravity is a force that keeps you on the ground. If we didn't have gravity we would float up to space, you would freeze and die. In space gravity is a small thing. Aliens can resist it because their homes are there. When you jump gravity pushes you down. As earth has as much larger mass than humans mass.



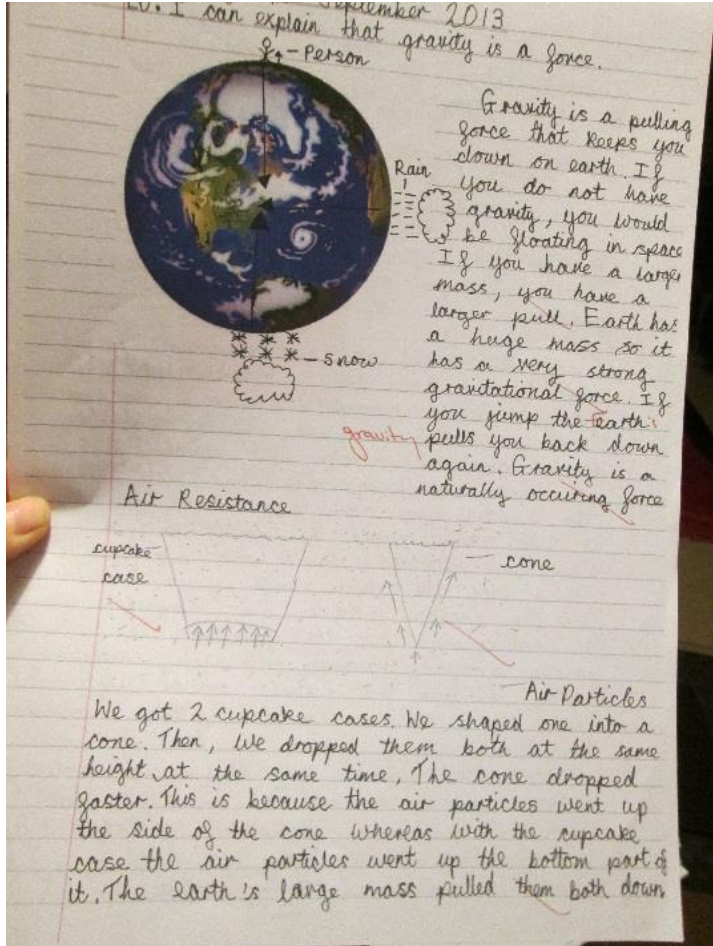
Stage 3 – the writing links cause and effect e.g. if we didn't have gravity we would float up to space. However vocabulary is not used correctly i.e. gravity pushes you down.



Gravity is a pulling force that keeps you down on earth. If you do not have gravity, you would be floating in space. If you have a large mass, you have a larger pull. Earth has a huge mass so it has a very strong gravitational force if you jump the earth pulls you back down again. Gravity is a naturally occurring force.

#### Air resistance

We got 2 cupcake cases. We shaped one into a cone. Then, we dropped them both at the same height at the same time. The cone dropped faster. This is because the air particles went up the side of the cone whereas with the cupcake case the air article went up the bottom part of it. The earth's large mass pulled them both down.



Stage 5 – scientific vocabulary is used correctly and explained. Knowledge is applied in a familiar context i.e. using knowledge of air resistance to explain the cupcake cases observations.

The cone pushed the air particles away because the end of it is shaped into a point. The cupcake base hit air resistance whereas the cones shape made it go faster.

Do you think the amount of surface area played a role?  
Yes, I think it did.

Monday 16th September 2013  
LO: To write our observations using scientific language.



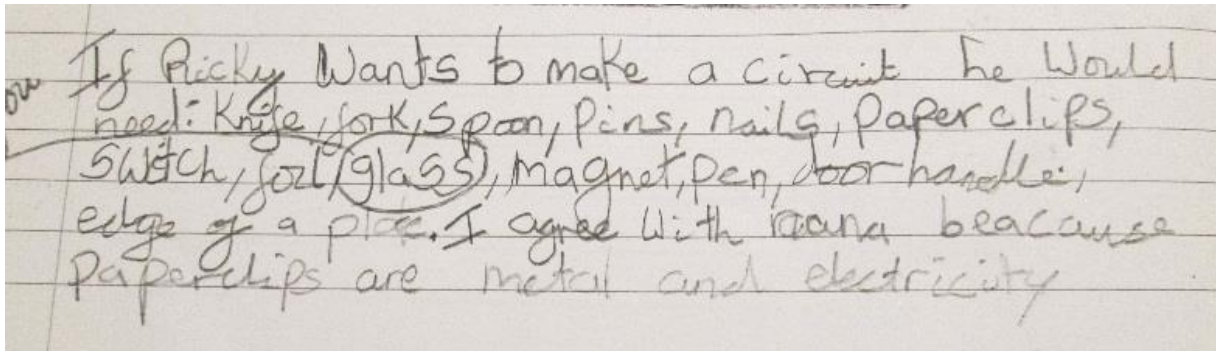
# Electricity

Year 4 national curriculum objectives:

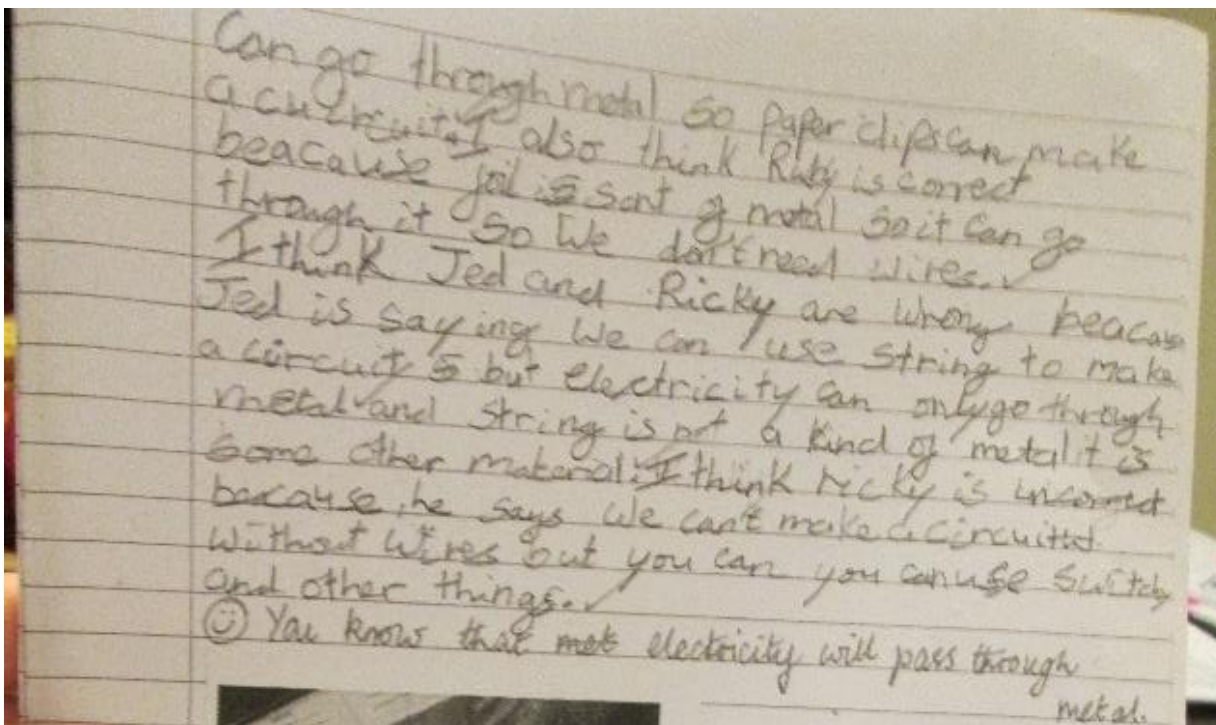
- recognise some common conductors and insulators, and associate metals with being good conductors.

If Ricky wants to make a circuit he would need: knife, fork, spoon, pins, nails, paper clips, switch, foil, glass, magnet, pen, door handle, edge of plate. I agree with Nana because paperclips are metal and electricity can go through metal so paperclips can make a circuit. I also think Ruby is correct because foil is sort of a metal so it can go through it so we don't need wires. I think Jed and Ricky are wrong because Jed is saying we can use string to make a circuit but electricity can only go through metal and string is not a kind of metal it is some other material. I think Ricky is incorrect because he says we can't make a circuit without wires but you can use a switch and other things.

Stage 3 – gives simple explanations e.g. paperclips are metals and electricity can go through metal. Shows understanding that string is not a metal and so electricity will not go through it. There is no use of the words conductor or insulator at this point.

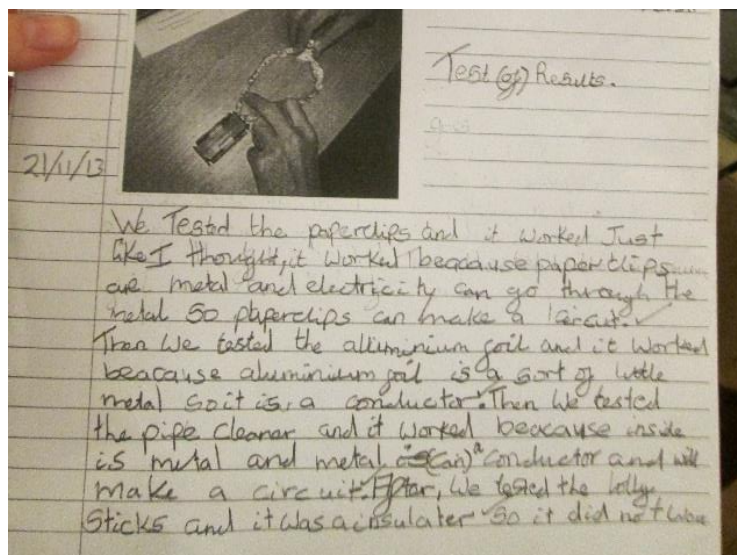


ow If Ricky Wants to make a circuit he would need: Knife, fork, spoon, pins, nails, paperclips, switch, foil (glass), magnet, pen, door handle, edge of a plate. I agree with nana because paperclips are metal and electricity

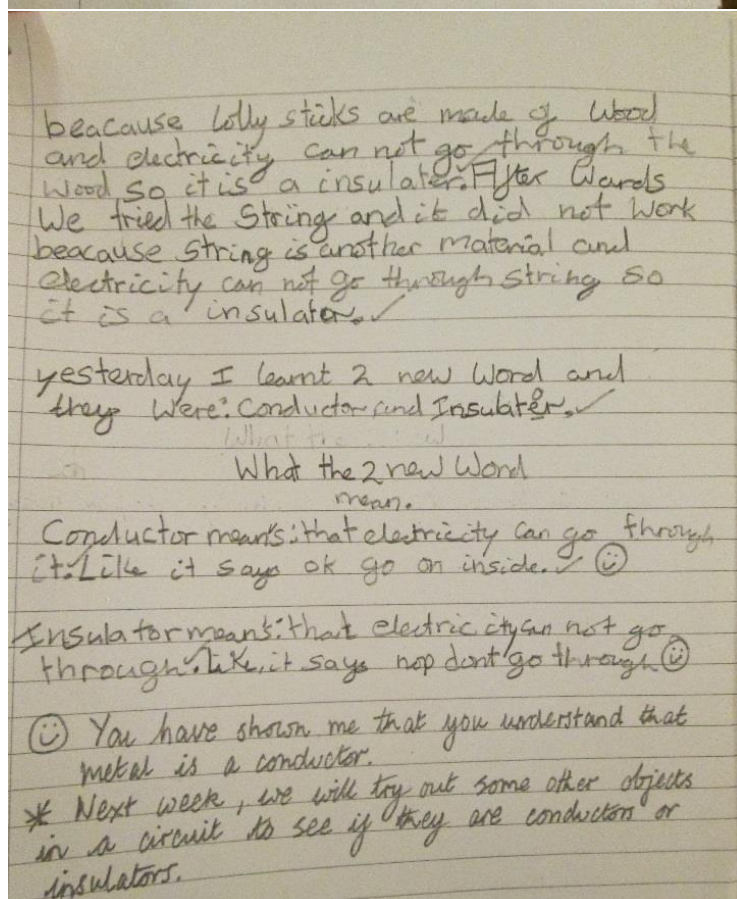


Can go through metal so paperclips can make a circuit. I also think Ruby is correct because foil is sort of metal so it can go through it so we don't need wires. I think Jed and Ricky are wrong because Jed is saying we can use string to make a circuit but electricity can only go through metal and string is not a kind of metal it is some other material. I think Ricky is incorrect because he says we can't make a circuit without wires but you can use switch and other things. ☺ You know that metal electricity will pass through metal.

(Same child later in the lesson) We tested the paper clips and it worked just like I thought, it worked because paperclips are metal and electricity can go through the metal so paperclips can make a circuit. Then we tested the aluminium foil and it worked because aluminium foil is a sort of little metal so it is a conductor. Then we tested the pipe cleaner and it worked because inside is metal and metal can conductor and will make a circuit. After we tested the lolly sticks and it was an insulator so it did not work because lolly sticks are made of wood and electricity cannot go through the wood so it is an insulator. Afterwards we tried the string and it did not work because string is another material and electricity cannot go through string so it is an insulator.



Stage 4 – the words conductor and insulator are now used correctly



(Same child reflection on the following day)  
Yesterday I learnt 2 new words and they were:  
conductor and insulator

Conductor means: electricity can go through it. Like it says OK go on inside.  
Insulator means: electricity cannot go through. Like it says nope don't go through.

Stage 5 – this last part of the writing demonstrates an understanding of the words insulator and conductor.

Could have been extended by given further examples of conductors and insulators that were not tested as part of the lesson